Invention Disclosu..

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Attorney ?PB	Docket Number 199-0438
TC GPB	Classification 04.05.10

Short Descriptive Title of Invention:
Anti-Rollover Stability Control

CPSC

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Department Name & Number: Brakes, Vac Dist & Chassis Ctrl T584	Department Name & Number: Brakes, Vac Dist & Chassis Ctrl T584	Department Name & Number:
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COMPLETE THE FOLLOWING AND THE ATTACHED PAGES

1. What do you consider to be the new technology of the invention?

Supplement current IVD systems with roll rate sensor for roll instability identification and control.

2. Identify the purpose/function of the new technology(s) of the invention and advantages over prior technology.

Active control of roll instability. Brake force applied on laden wheel(s) reduces tire lateral force(s) and therefore reduces vehicle overturning moment and reduces occurrence of vehicle roll over.

3. Identify the closest technology, if any, of which you are aware. Provide copies, if available.

IVD - Stability Control.

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4. Identify first dated record(s) of invention.	5. Date a working model, device or process was or will be completed.
6. If the invention will be released for production, identify model and year.	7. Identify a government agreement, partnership, consortium, or other company involved with conception or first building of the invention, if any.
8. If disclosed to non-Company personnel, identify recipient and date.	

9. Advanced Project No., if any.	10. Name of related Technology Council, if any.	11. Name of related Technology Forum, if any.

DESCRIPTION OF THE INVENTION (USE INK)

Provide a written description of the invention, preferably with reference to attached prints, sketches, photos, components, reports, etc. The description should provide a clear, complete understanding of the invention, including its operation and environment. All attachments must be signed by the inventor(s), dated and witnessed.

Sensors, including rotation rate along any combination of axis and/or acceleration along any combination of axis and/or any combination of speed sensors and/or any form of GPS information is/are used to identify a vehicle instability or tendency towards instability in the roll plane. This information is then used to take action in reducing the overturning moment generated by tire lateral forces. This action can be implemented through any means or combination of: modifying the longitudinal force of the tire through inducing a rotational torque on the wheel and/or direct modification of the tire lateral force through actively modifying the tire steer or camber angle and/or modifying the tire normal force through suspension control.

One such realization of the invention includes the augmentation of an existing IVD system with a roll rate sensor. This roll rate sensor is used in conjunction with the existing IVD sensor set and new software strategies to identify vehicle roll and roll instability. New software strategies then determine appropriate brake forces to apply in response to vehicle roll over instability. Existing IVD hydraulics are used to build brake forces on the laden wheels to reduce tire lateral forces. This tire lateral force reduction induces a compensating torque in the roll plane which reduces the resultant vehicle overturning moment and facilitates increased vehicle robustness to roll over.

Please see attachments for further detail.

DESCRIPTION OF THE INVENTION (cont'd.)

See Attached

LIST ALL ATTACHMENTS:

Diagram of System Principal, Inertial Sensor Offset Compensation and Filtering, Chassis Roll Angle Estimation and Compensation, Relative Roll Calculation, Feedback and Desired Pressure Calculation.

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I hereby consent to Ford Motor Company and its subsidiaries transmitting to and storing in any computer database any information contained in or relating to this invention disclosure and to the invention described herein.

READ AND UNDERSTOOD:

Leonard M Brown	3/30/99	Todd Allen Brown	3/30/99
Signature of Witness	Date	Signature of Inventor	Date
David E Wimmard	3/30/99	Douglas Scott Rhode	3/30/99
Signature of Witness	Date	Signature of Inventor	Date
Guy M Villet	3/30/99		
Signature of Witness	Date	Signature of Inventor	Date

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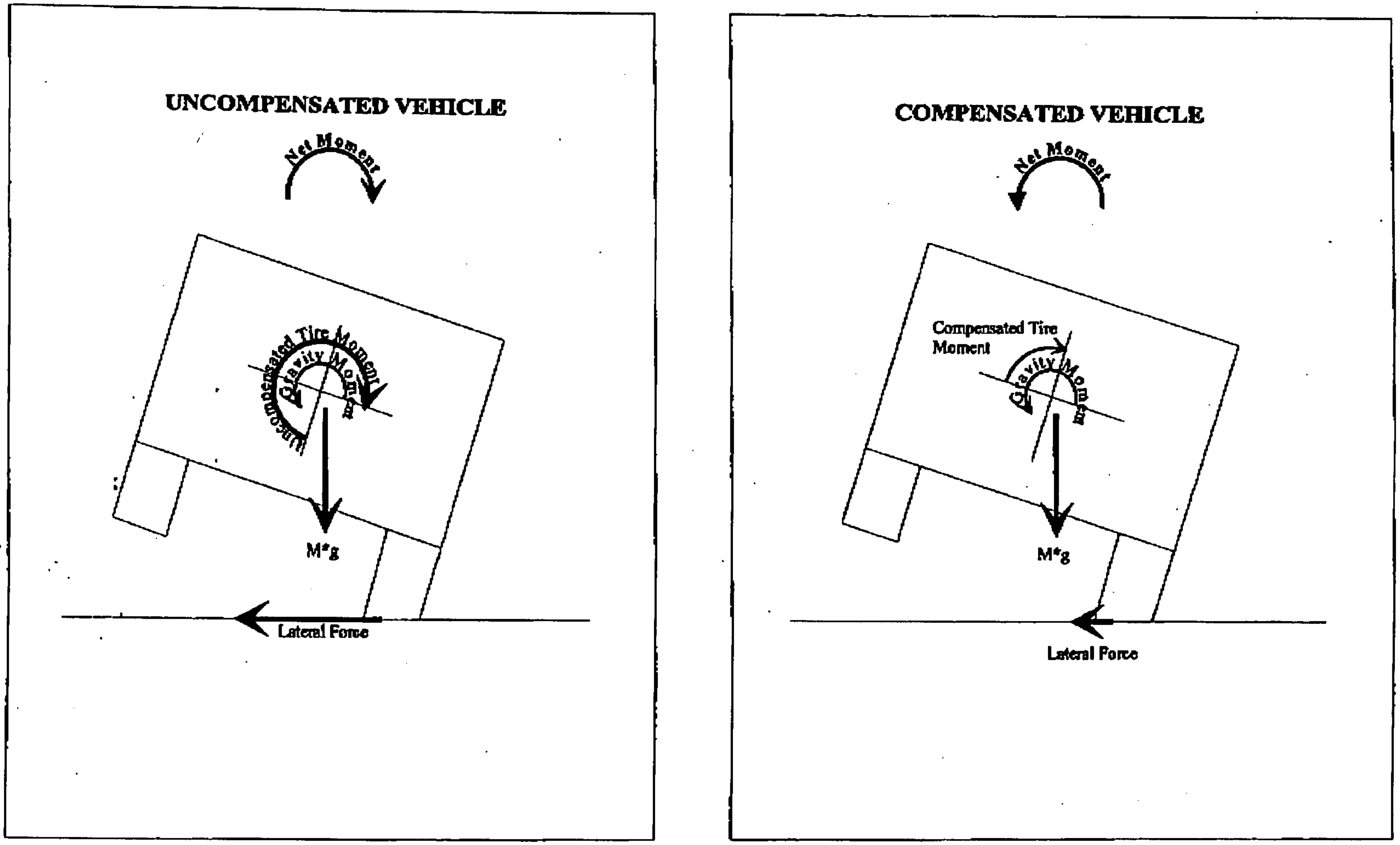
ROLL STABILITY CONTROL
DIAGRAM OF SYSTEM PRINCIPAL



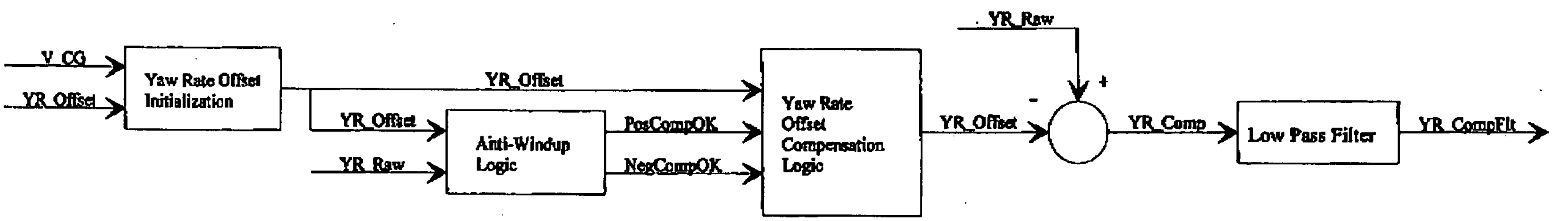
3/30/99

3/30/99

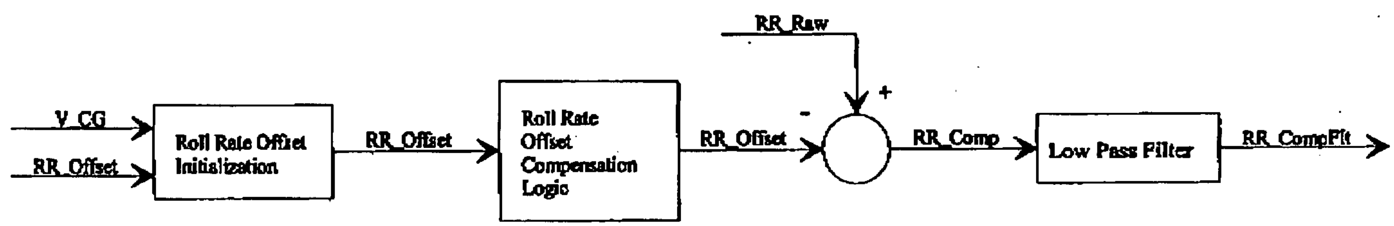
ithor: Todd Allen Brown/TBROWN9
ue Date: 30 March, 1999
ision: 990330

ROLL STABILITY CONTROL
INERTIAL SENSOR OFFSET COMPENSATION AND FILTERING

YAW RATE



ROLL RATE



LATERAL ACCELERATION

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Douglas S. Rhode 3/30/99

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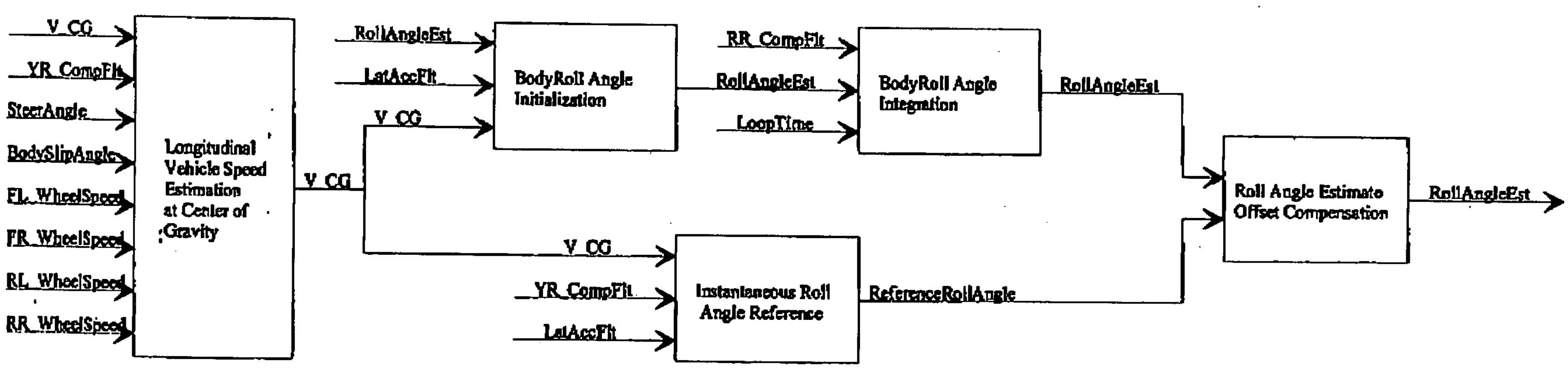
ROLL STABILITY CONTROL
CHASSIS ROLL ANGLE ESTIMATION AND COMPENSATION



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Douglas S. Rhode 3/30/99

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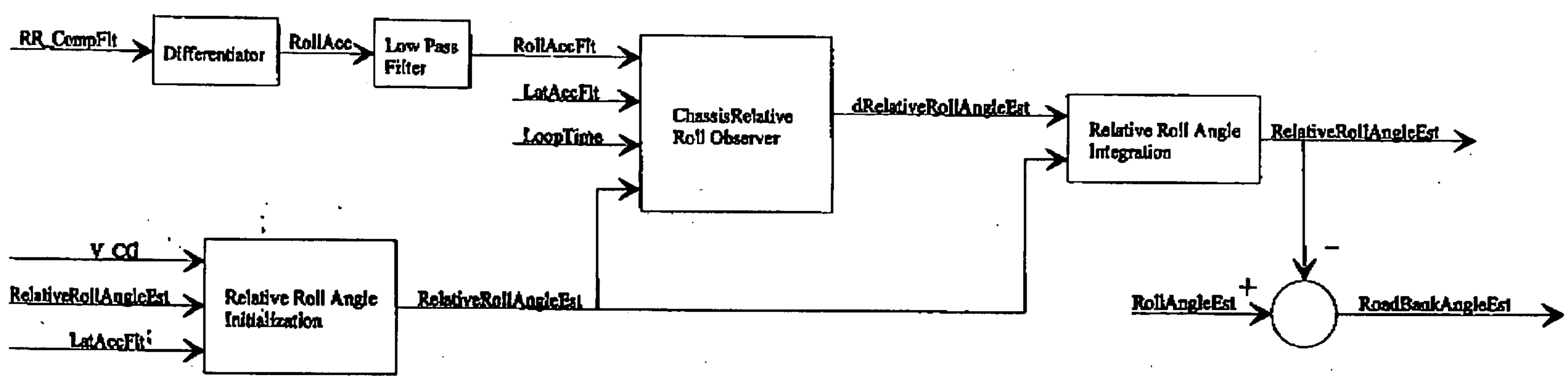
Date: 30 March, 1999
ion: 990330

ROLL STABILITY CONTROL
RELATIVE ROLL CALCULATION



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: Date: 30 March, 1999
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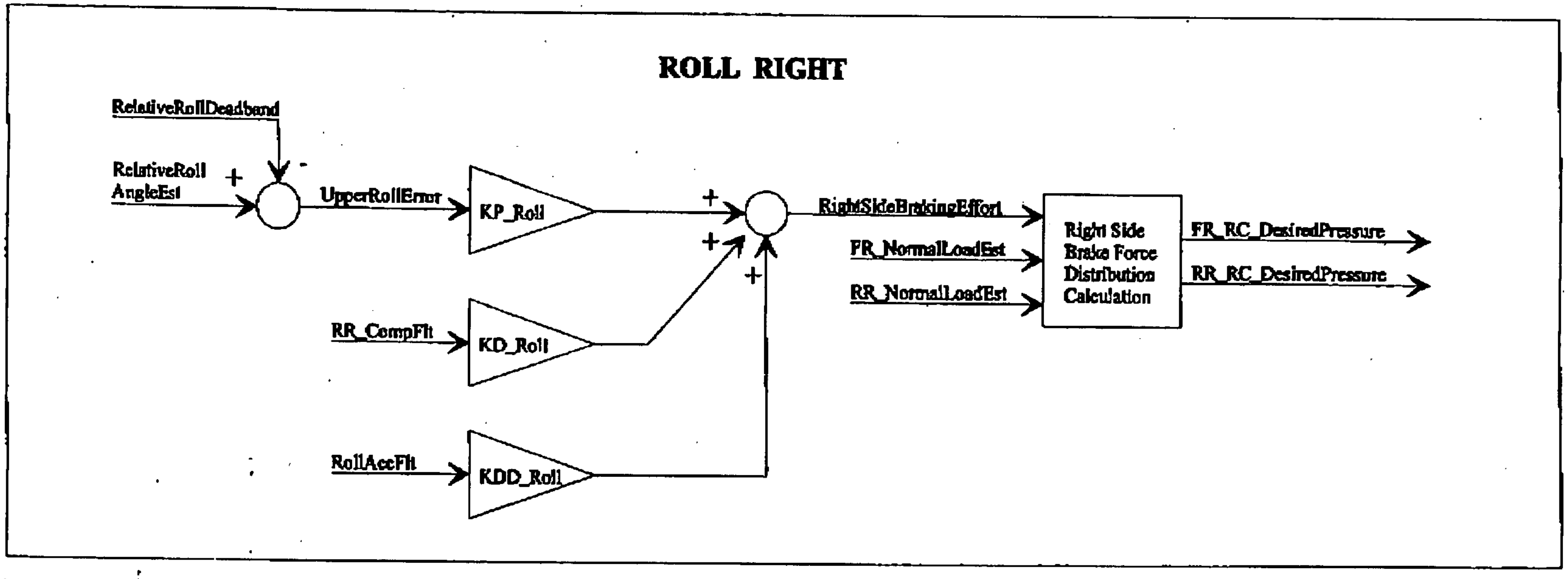
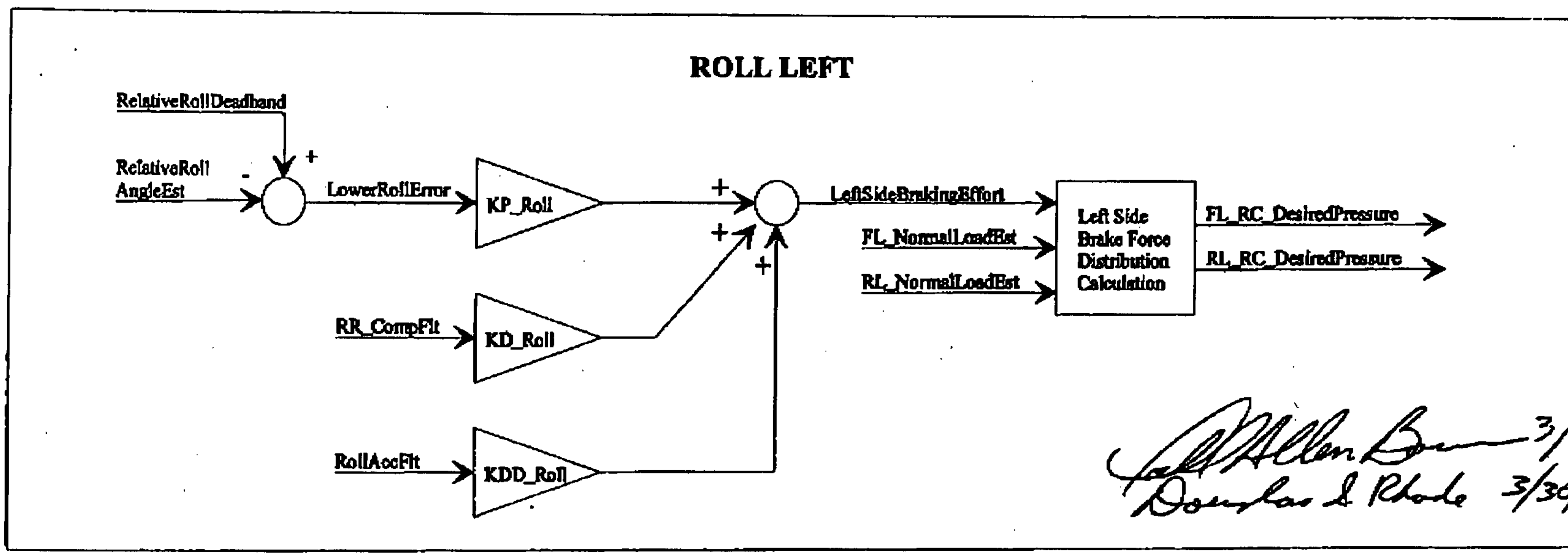
ROLL STABILITY CONTROL
CALCULATION OF SYSTEM FEEDBACK





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Date: 30 March, 1999
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Identification

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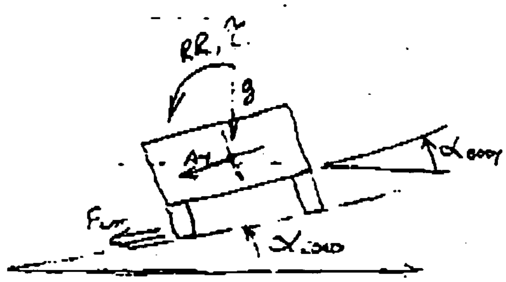


$$A_{y_{calc}} = \frac{F_{lat}}{M} \qquad (1)$$

$\alpha_{roll} = \alpha_{body} - \alpha_{road};$

$\dot{\alpha}_{roll} = \dot{\alpha}_{body} - \dot{\alpha}_{road};$ $\alpha_{road} =$

$\dot{\alpha}_{body}$ = Measured;

A_y = Measured;

α_{body} = Estimated;

$\tau_{susp} = -K_{roll} * \alpha_{roll} - C_{roll} * \dot{\alpha}_{roll};$

$\Sigma\tau = \tau_{susp} - A_y * M * H_{cg} = I_{roll} * \ddot{\alpha}_{body};$

$-K_{roll} * \alpha_{roll} - C_{roll} * \dot{\alpha}_{roll} - A_y * M * H_{cg} = I_{roll} * \ddot{\alpha}_{body};$

$\alpha_{roll} = \alpha_{roll}Z1 + d\alpha_{roll};$

$\dot{\alpha}_{roll} = \dfrac{d\alpha_{roll}}{\text{LOOPTIME}};$

$-K_{roll} * (\alpha_{roll}Z1 + d\alpha_{roll}) - C_{roll} * \dfrac{d\alpha_{roll}}{\text{LOOPTIME}} - A_y * M * H_{cg} = I_{roll} * \ddot{\alpha}_{body};$

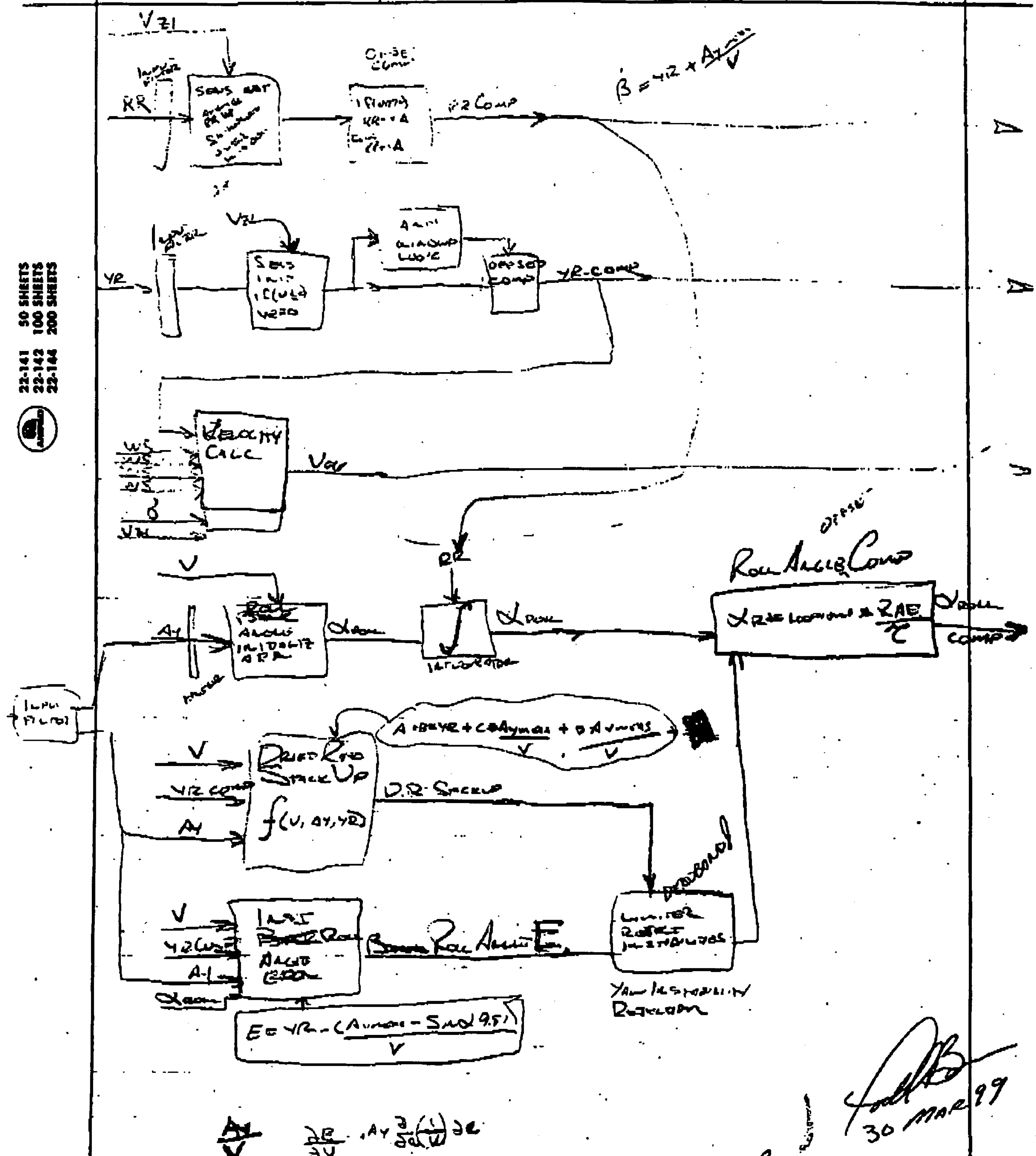
$-K_{roll} * \alpha_{roll}Z1 - \left(K_{roll} + \dfrac{C_{roll}}{\text{LOOPTIME}}\right) * d\alpha_{roll} - A_y * M * H_{cg} = I_{roll} * \ddot{\alpha}_{body};$

$$\boxed{d\alpha_{roll} = \frac{1}{K_{roll} + \dfrac{C_{roll}}{\text{LOOPTIME}}}\left(K_{roll} * \alpha_{roll}Z1 + A_y * M * H_{cg} + I_{roll} * \ddot{\alpha}_{body}\right);}$$

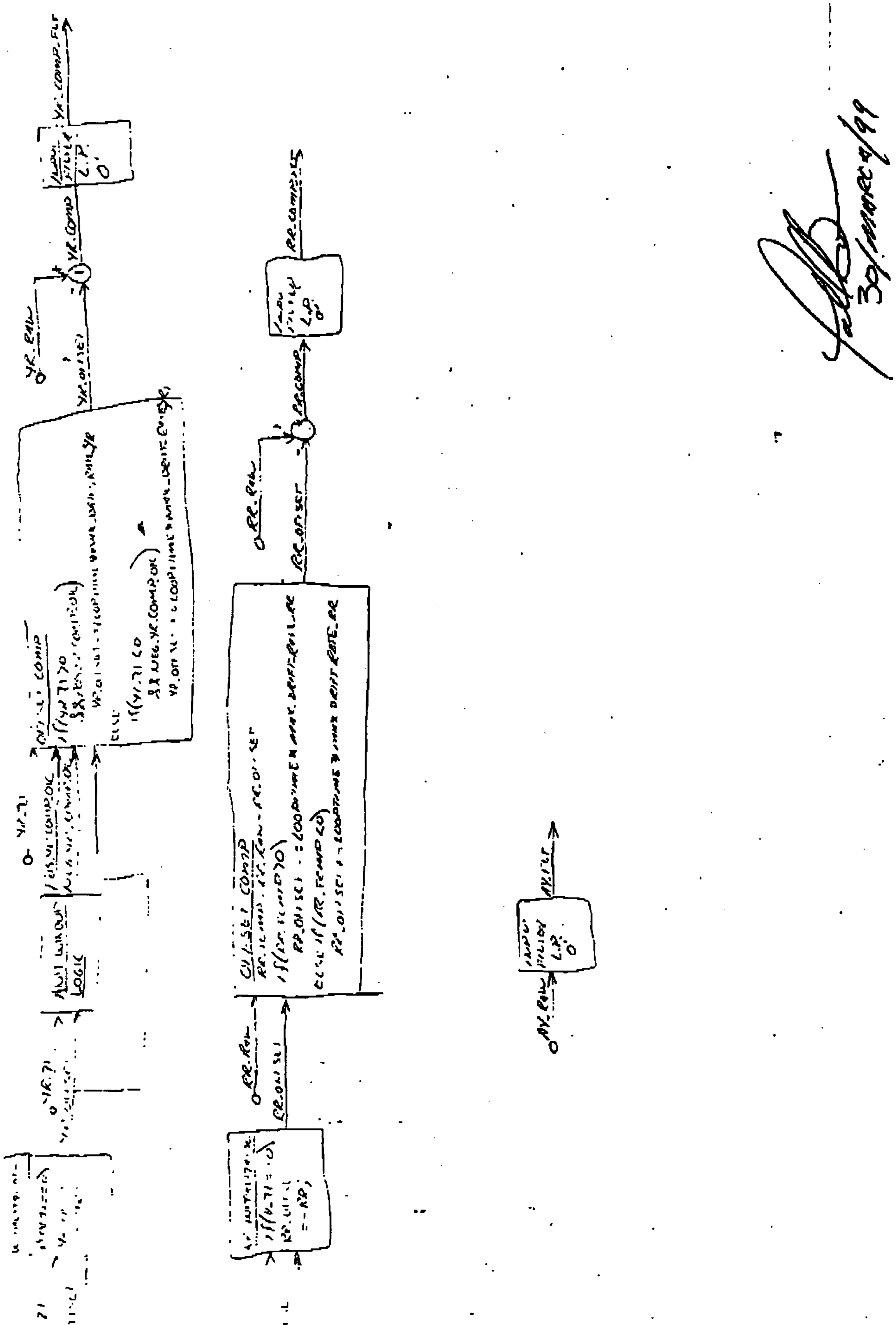
if ($\alpha_{roll} > \alpha_{lift}$) $d\alpha_{roll}$ *= 2; /* Account For Wheel Lift */

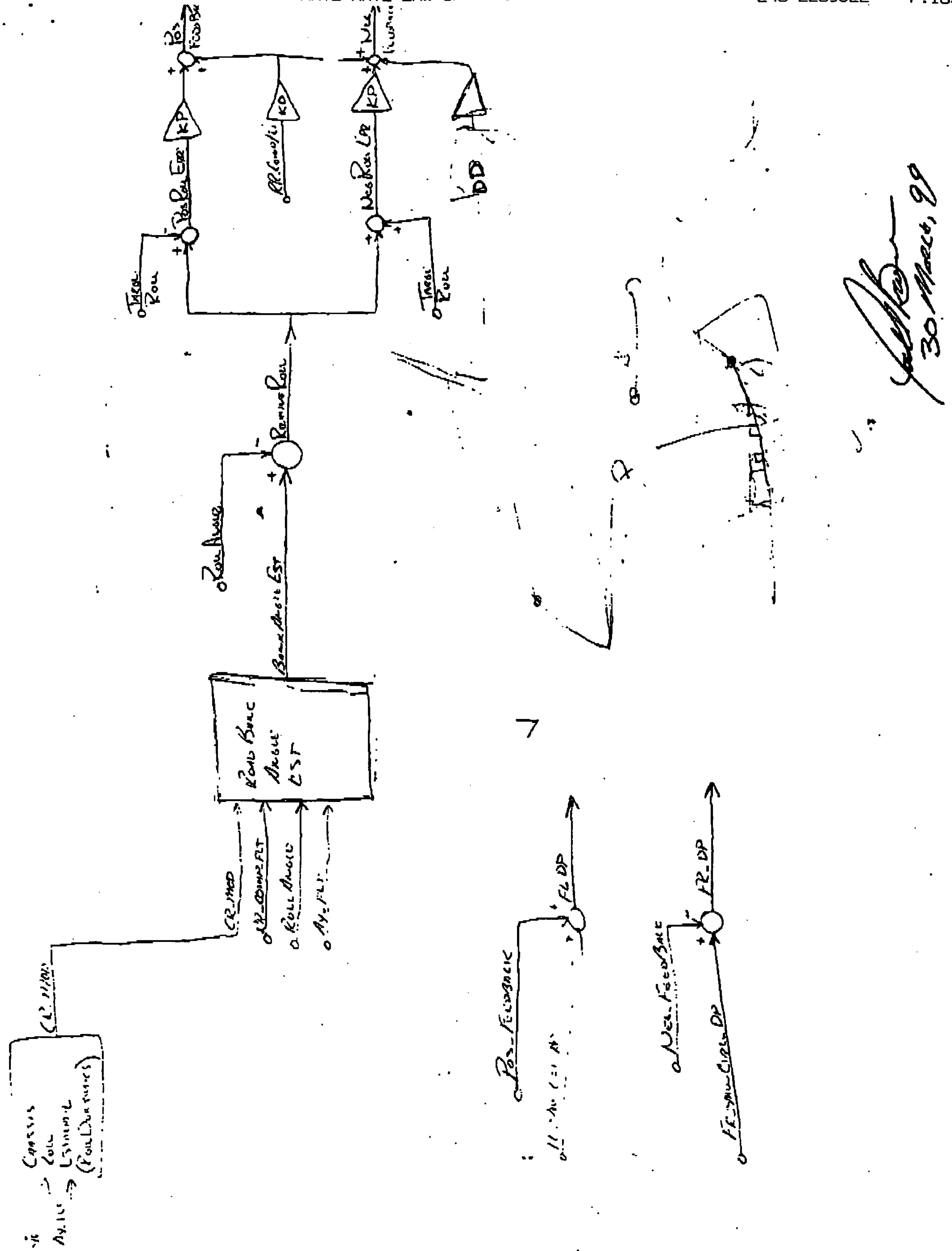
$\boxed{\alpha_{roll} += d\alpha_{roll};}$

$\boxed{\alpha_{road} = \alpha_{body} - \alpha_{roll};}$

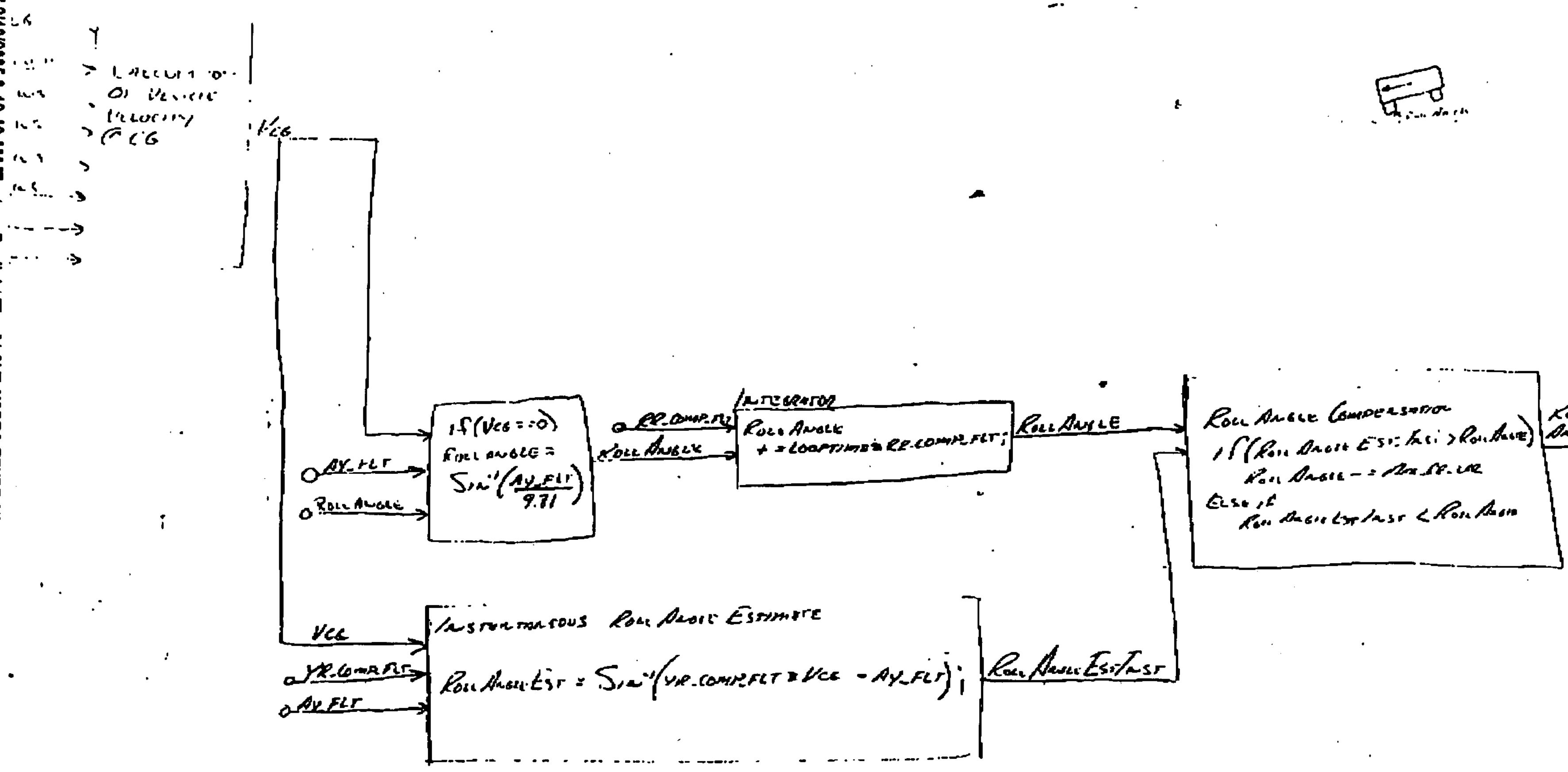

RR
YR
YR-COMP
Velocity Calc
V
AY
Roll Angle Comp
Integrator
Drift Rate Stack Up
$f(V, AY, YR)$
D.R. Stackup
Deadband
Yaw Instability Detection
30 MAR 99

SENSOR OFFSET COMPENSATION AND FILTERING




KP
KD
KP
DD
Road Bank Angle Est
Roll Angle
FL_DP
FR_DP
7
30 March, 99

Chassis Velocity And Roll Angle Estimation



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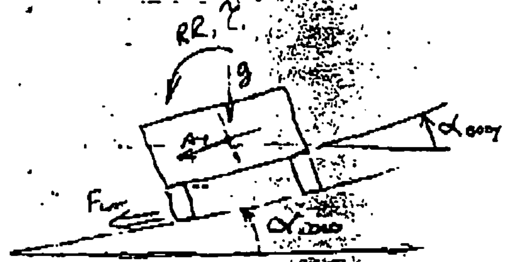
IDENTIFICATION



(1)

$$Ay_{meas} = \frac{F}{M}$$

$\alpha_{roll} = \alpha_{body} - \alpha_{road}$;

$\dot{\alpha}_{roll} = \dot{\alpha}_{body} - \dot{\alpha}_{road}$;

$\dot{\alpha}_{body}$ = Measured;

Ay = Measured;

α_{body} = Estimated;

$\tau_{susp} = -K_{roll} * \alpha_{roll} - C_{roll} * \dot{\alpha}_{roll}$;

$\sum \tau = \tau_{susp} - Ay * M * H_{cg} = I_{roll} * \ddot{\alpha}_{body}$;

$-K_{roll} * \alpha_{roll} - C_{roll} * \dot{\alpha}_{roll} - Ay * M * H_{cg} = I_{roll} * \ddot{\alpha}_{body}$;

$\alpha_{roll} = \alpha_{roll}\, z1 + d\alpha_{roll}$;

$$\dot{\alpha}_{roll} = \frac{d\alpha_{roll}}{\text{LOOPTIME}};$$

$-K_{roll} * (\alpha_{roll}\, z1 + d\alpha_{roll}) - C_{roll} * \frac{d\alpha_{roll}}{\text{LOOPTIME}} - Ay * M * H_{cg} = I_{roll} * \ddot{\alpha}_{body}$;

$-K_{roll} * \alpha_{roll}\, z1 - (K_{roll} + \frac{C_{roll}}{\text{LOOPTIME}}) * d\alpha_{roll} - Ay * M * H_{cg} = I_{roll} * \ddot{\alpha}_{body}$;

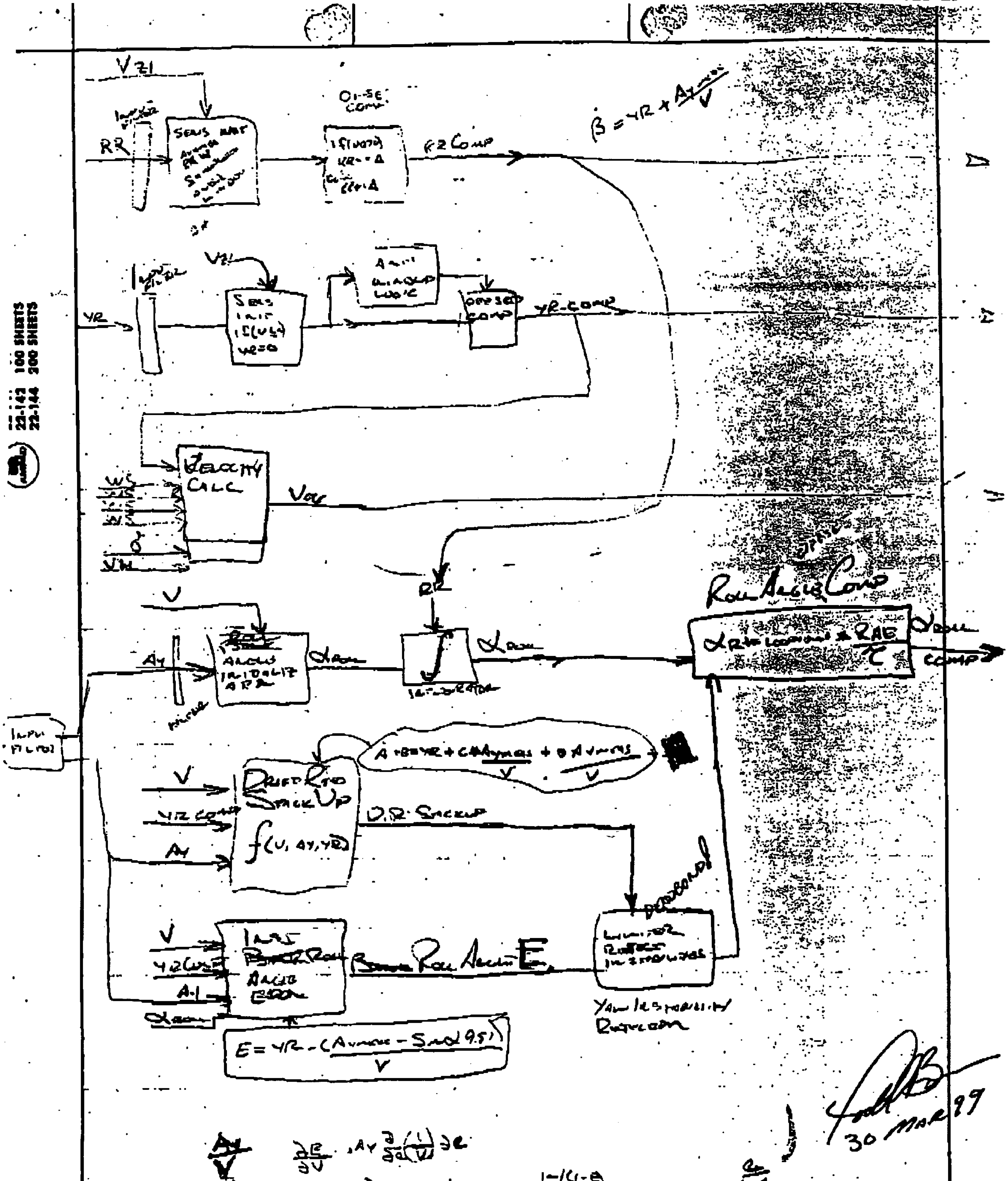
$$\boxed{d\alpha_{roll} = \frac{-1}{K_{roll} + \frac{C_{roll}}{\text{LOOPTIME}}} \left(K_{roll} * \alpha_{roll}\, z1 + Ay * M * H_{cg} + I_{roll} * \ddot{\alpha}_{body} \right);}$$

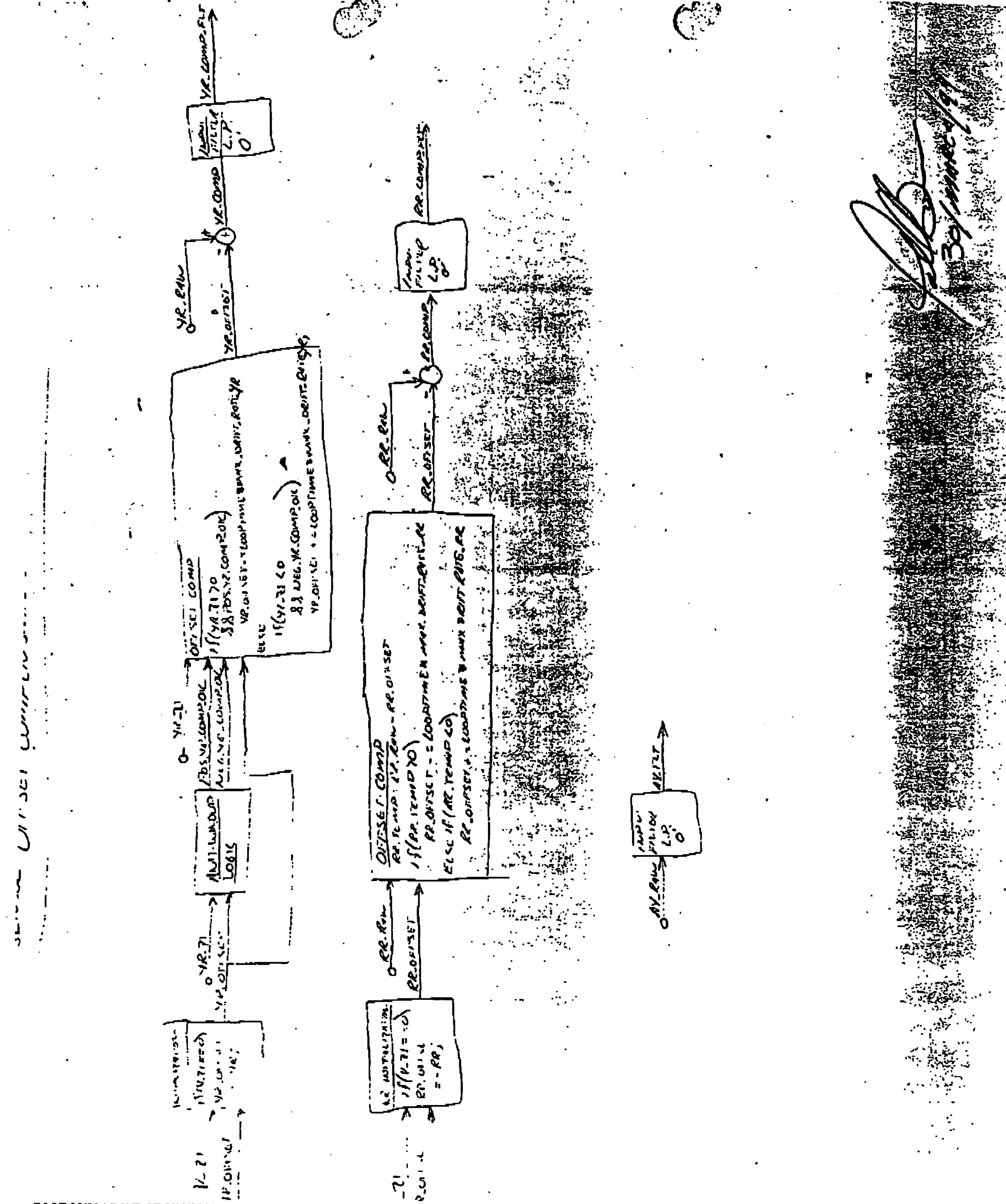
if ($\alpha_{roll} > \alpha_{lift}$) $d\alpha_{roll}$ *= 2; /* Account for Wheel Lift */

$\boxed{\alpha_{roll} += d\alpha_{roll};}$

$\boxed{\alpha_{road} = \alpha_{body} - \alpha_{roll};}$

30 Mar 99


VZ1
RR
YR
YR COMP
VELOCITY CALC
V
Ay
INTEGRATOR
ROLL ANGLE COMP
COMP
30 MAR 99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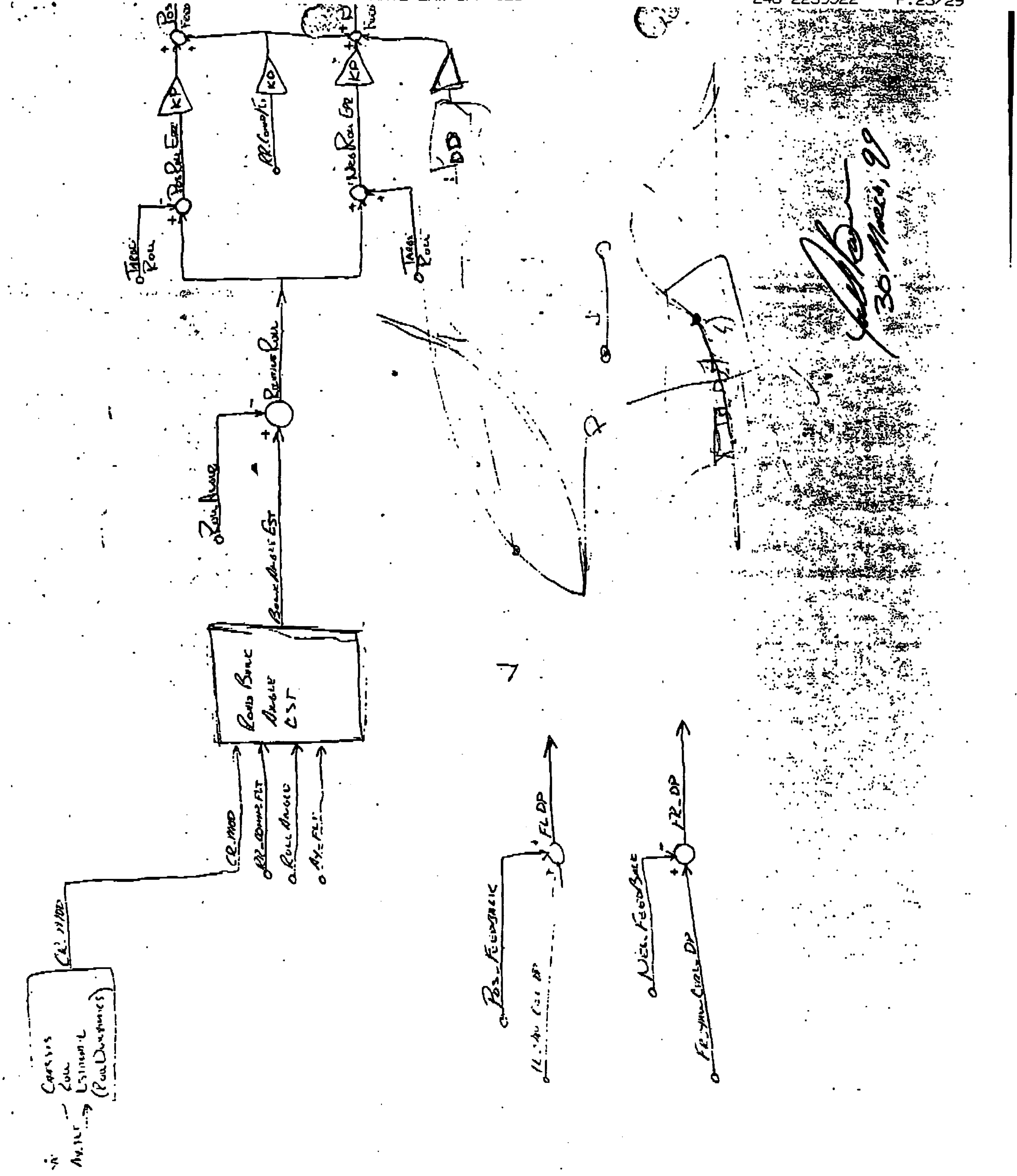
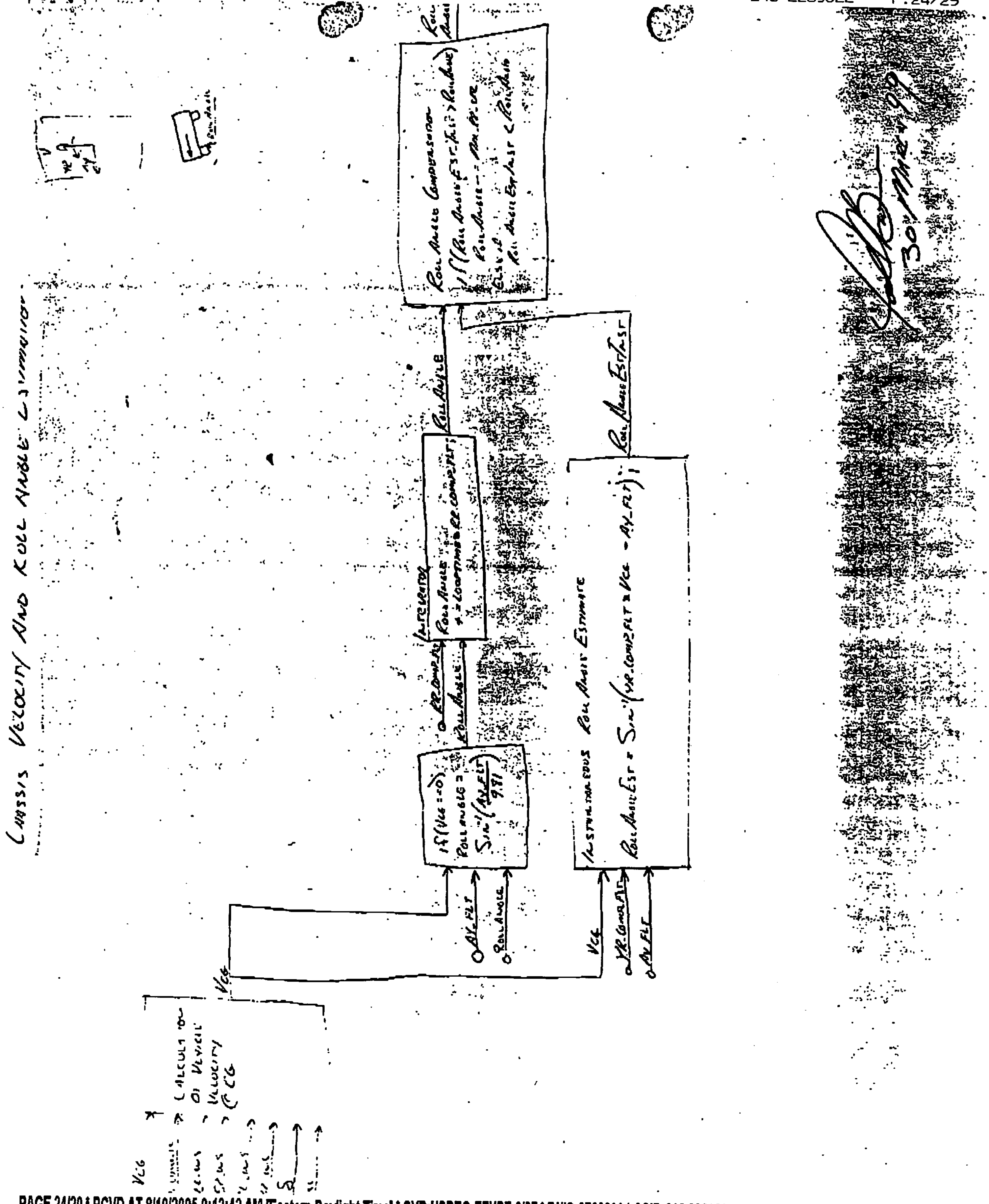
ANTI-WINDUP LOGIC
YR_RAW
YR_OFFSET
YR_COMP
RR_RAW
RR_OFFSET
RR_COMP
AY_RAW
L.P.


KP
KD
KP
DD
Target Roll
Target Roll
Roll Angle
Road Bank Angle EST
FL DP
FR_DP
Pos_Feedback
Neg_Feedback
30 March, 99


Chassis Velocity And Roll Angle Estimation
Instantaneous Roll Angle Estimate
Integrator
Roll Angle Compensation